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1. Title of the Invention: Liquid crystal display panel

° Patent Application      Sho 53-104210  
Application              August 25, 1978

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## SPECIFICATION

### 1. Title of the Invention

Liquid crystal display panel

### 2. Scope of Claim for Patent

5        1. In a liquid crystal display panel utilizing a semiconductor substrate provided with a plurality of active elements and passive elements, said liquid crystal panel characterized in that said semiconductor substrate is provided with electrode films in a matrix form corresponding to said active elements and said passive elements  
10 over a surface of the semiconductor substrate, which surface has been planarized, and a surface of said semiconductor substrate is covered with an orientation treatment film.

15        2. The liquid crystal display panel of claim 1, wherein the planarized surface of the semiconductor substrate is formed by coating an insulating material in varnish form at a film thickness of 1 to  $5\mu$  on the semiconductor substrate having big irregularity.

      3. The liquid crystal display panel of claim 1, wherein the orientation treatment film on the surface of the semiconductor substrate is an oblique evaporation film of SiO.

20        4. The liquid crystal display panel of claim 1, wherein the liquid crystal has a twisted nematic structure.

      5. The liquid crystal display panel of claim 1, wherein the liquid crystal comprises polygenetic color and nematic liquid crystal.

## "Detailed Description of the Invention"

The present invention relates to a liquid crystal display panel. Further, the present invention relates to a surface configuration and a surface treatment of a semiconductor substrate which is utilized for one of substrates constituting a display cell.

Recently, the display device is extremely advanced. Especially, the display device using liquid crystal has many advantages of low voltage driving, low power, thin type and long life. In these days, it is utilized for various kinds of display devices such as wristwatch, pocket calculator. On the other hand, as a practical uses, the display device is applied for character display and television by making the best use of the above mentioned advantages of the liquid crystal display device. In this way, in case that the number of rows and columns of matrix display is big, it is effective to statically drive a liquid crystal utilizing active elements, which are prepared on a semiconductor substrate as one of the substrates constituting the display cell. The present invention relates to this static drive type liquid crystal display device.

Fig. 1 shows a conventional liquid crystal display panel. Fig. 1 shows a structural drawing of the conventional liquid crystal display panel. Reference numeral 1 in the figure shows a semiconductor substrate comprising active elements or passive elements. A liquid crystal driving electrode 2 is prepared on a surface of a semiconductor substrate in a form of matrix. Reference numeral 5 shows a spacer, and a transparent conductive film 4 is formed on an upper side glass plate 3. Reference numeral 6 shows a liquid crystal. Fig. 2 shows a cross sectional drawing of a semiconductor substrate. In Fig. 2, a region enclosed with two dot chain line equals to one pixel. One transistor and one condenser are included in one pixel. In the figure, reference numeral 7 shows, for example, a n-type silicon substrate, 8 shows a p-type diffused layer, 9 shows a n<sup>+</sup> type diffused layer, 10 shows a field oxide film, 11 shows an SiO<sub>2</sub> film, 12 shows a doped polysilicon film, and 13 shows a CVD SiO<sub>2</sub> film. 14 is an aluminum film comprising electrode and wiring. 15 is a protective film, which is usually a CVD SiO<sub>2</sub> film. In Fig. 2, the part A is a transistor and the part B is a condenser. As apparent from Fig. 2, in case that the semiconductor substrate is manufactured by a conventional process, a step of approximately 1 to 3  $\mu$  is formed on the surface of the semiconductor substrate. The unevenness of the surface is generally large although it depends slightly upon the configuration of the elements embedded in the semiconductor substrate and the manufacturing process. Therefore, as shown in Fig. 2, when an orientation treatment is

conducted on the surface of the semiconductor substrate having big irregularity by oblique evaporation of SiO or the like, there is formed one surface on which the SiO film is formed and another surface on which no SiO<sub>2</sub> film is formed as shown in Fig. 3. In Fig. 3, 16 is the semiconductor substrate having irregularity on the surface thereof. 17 is a direction of evaporation of SiO particles which are deposited by an oblique evaporation at an angle  $\theta = 70$  to  $89^\circ$  and 18 is an SiO film formed on a semiconductor substrate. As apparent from the figure, the bigger the irregularity formed on the surface of the semiconductor substrate 16 is, the smaller the proportion of the surface having the SiO film formed thereon is. If a proportion of the surface having no SiO film is large, this part does not contribute to the actual display. Therefore, the contrast extremely reduces and the function as a display device deteriorates. The present invention removes the defect of the conventional liquid crystal display panel. Referring to the detail examples, the object of the present invention will be set forth in the description.

Usually, the surfaces of two substrates constituting the liquid crystal display panel needs to be treated with a horizontal orientation or vertical orientation treatment depending upon the display mode and the kind of the liquid crystal. There are many methods as an orientation treatment, for example, rubbing process, oblique evaporation, and dipping method using such as silane coupling agent. However, in view of characteristic and homogeneous quality, oblique evaporation process is best. In the oblique evaporation method, SiO or Teflon is evaporated on the substrate in vacuum at an angle of  $70$  to  $89^\circ$  and thin and long lines are innumably formed at intervals of several hundreds to several thousands Å(angstrom) on the surface of the substrate in order to conduct the orientation of the liquid crystal. In case of conducting oblique evaporation to glass substrate, an oblique evaporation film 20 is deposited on an entire surface because a surface of a glass plate 19 is flat as shown in Fig. 4. On the other hand, in case that a semiconductor substrate is used, a step of  $1.0\mu$  or more is formed on a surface as mentioned above. If a semiconductor substrate having a step of  $1.0\mu$  on the surface is subjected to an oblique evaporation at an angle of  $80^\circ$ , an oblique evaporation film is not deposited on a region of  $5.8\mu$  at one side of the step portion. The present invention has been made to solve the problem described above, thereby obtaining the display panel having high contrast and the excellent image quality. Concretely, in case that the surface of the semiconductor substrate which contributes to the display is flatten and conduct an oblique evaporation, it characterized that a ratio of portion having no oblique evaporation film is reduced. Fig. 5 shows a cross-section

al drawing of construction of a substrate having reduced a step on the surface of the semiconductor substrate. Reference numerals 7 to 14 in Fig. 5 corresponds to that in Fig. 2. Reference numeral 21 in Fig. 5 is a layer to flatten the surface of the semiconductor substrate, which is the point of the present invention. Further, as a liquid crystal driving electrode, a transparent conductive film layer or a metal layer 22 is formed on the layer 21. The liquid crystal driving electrode is connected with a lower wiring 14 by through hole. The layer 21 which flattens the surface of the semiconductor substrate may comprise polyimide resin, glass having low melting point, insulating material, or the like. In case that a polyimide resin is used, a polyimide film having a thickness of 1 to  $5\mu$  on the surface of the semiconductor substrate by polyimide varnish and spinner application. In this case, silane coupling agent is applied to a base semiconductor substrate to enhance the adherence between the base film and a polyimide film. Subsequently, it is cured at a temperature of 350 to 550°C. Through holes may be formed by photoetching by using hydrazine solution or NaOH. Then, a liquid crystal driving electrode may be formed. Polyimide is used as a flattening material for the semiconductor substrate because it is superior in heat resistance to other organic resins and it can be formed at a thickness of 10  $\mu$  without crack. Furthermore, polyimide is superior in passivation effect. However, the present invention is applied to not only a polyimide film but also a glass having low melting point, for example, a lead glass comprising  $PbO_2$  as a main component, a zinc glass comprising  $ZnO_2$  as a main component or a phosphorus glass comprising  $P_2O_5$  as a main component. If a step of 0.5  $\mu$  or less is formed on the surface of the semiconductor substrate after deposition, the above mentioned materials can be sufficient for the present invention. By an oblique evaporation, an orientation film is formed on a surface of the flatten semiconductor formed by the above mentioned process. Thereby, as shown in reference numeral 20 in Figs. 5 and 6, almost all display portions can be treated with an orientation process, so that the contrast of the liquid crystal display panel is remarkably improved and it is possible to obtain a good image of the display panel. In Fig. 6, reference numeral 23 is a semiconductor substrate having a planarized surface, and 24 is a liquid crystal driving electrode. By using the semiconductor substrate having the planarized surface according to the present invention, contrast of the liquid crystal display panel is improved to several times as compared with conventional one.

In the present invention, the substrate having a MOS type transistor is

explained as a semiconductor substrate, however, a substrate having TFTs or a SOS substrate may be used as the semiconductor substrate. Moreover, a semiconductor substrate may be consisting of not only active elements but also passive elements. When a liquid crystal display cell according to the present invention is applied to the liquid crystal display television, it is very effective to obtain a high contrast. In this case, a liquid crystal may be a twisted nematic type having low driving voltage or a nematic liquid crystal is mixed with dichroism color. If a semiconductor substrate having a flatten surface is used, display having an improved contrast can be obtained because the thickness of the liquid crystal can be uniform.

As above mentioned, the present invention relates to the liquid crystal display panel, which is characterized that a surface of the semiconductor substrate used for one side of the display panel is planarized to improve the contrast.

#### "Brief Explanation of The Drawings"

Fig. 1 illustrates a cross sectional structure of a liquid crystal cell.

Fig. 2 is a cross sectional view showing an irregularity, which is formed on the surface of a conventional semiconductor substrate.

Fig. 3 shows an orientation treatment of a substrate having a big irregularity.

Fig. 4 shows an orientation treatment of a glass having a planarized surface.

Fig. 5 shows a cross sectional view of a semiconductor substrate having a planarized surface in accordance with the present invention.

Fig. 6 shows an orientation treatment of a substrate having a planarized surface.

- |  |                                      |
|--|--------------------------------------|
| 1---semiconductor substrate                            | 2---liquid crystal driving electrode |
| 3---upper side glass plate                             | 4---transparent conductive film      |
| 5---spacer   | 6---liquid crystal                   |
| 7---n type silicon substrate                           | 8---p+ type diffused layer           |
| 9---n+ type diffused layer                             | 10---field oxide film                |
| 11---gate oxide film                                   | 12---doped polysilicon film          |
| 13---CVD SiO <sub>2</sub> film                         | 14---a second layer wiring           |
| 15---CVD SiO <sub>2</sub> film                         |                                      |
| 16---semiconductor substrate having a big irregularity |                                      |
| 17---oblique evaporation direction                     |                                      |
| 18---oblique evaporation film                          | 19---glass plate                     |

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20---oblique evaporation film

21---a layer to make a surface of semiconductor to be planarized

22---liquid crystal driving electrode

23---semiconductor substrate having a planarized surface

24---liquid crystal driving electrode

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## 12 公開特許公報 (A)

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51 液晶表示パネル

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## 明 細 書

発明の名称 液晶表示パネル

## 特許請求の範囲

(1) 表示セルを構成する一方の基板に、複数の能動素子及び受動素子をマトリックス状に配列した半導体基板を用いた液晶表示パネルにおいて、該半導体基板は表面酸化処理が施された基板表面上に複能動素子及び受動素子に対応してマトリックス状に電導膜が形成されておりかつ該半導体基板表面は能動処理液にて覆われていることを特徴とする液晶パネル。

(2) 半導体基板表面の表面酸化処理は、前記の新しい半導体基板上に、1—5μの厚さにてワニス状の材料を電着形成して成ることを特徴とする前記項1の範囲に1項記載の液晶表示パネル。

(3) 半導体基板表面の表面酸化処理は、前記の項1の範囲にあることを特徴とする前記項1の範囲に1項記載の液晶表示パネル。

項1記載の液晶表示パネル。

(4) 液晶表示パネル内の液晶は、ねじれネマチック構造を有することを特徴とする特許請求の範囲に1項記載の液晶表示パネル。

(5) 液晶表示パネル内の液晶は、多結晶型ネマチック液晶とから成ることを特徴とする特許請求の範囲に1項記載の液晶表示パネル。

## 発明の詳細な説明

本発明は液晶表示パネルに関するものである。さらに本発明は、表示セルを構成する一方の基板に用いた半導体基板の表面形状及び表面処理に関するものである。

なお、表示装置の構成は目を見れば分かるが、中でも液晶を用いた表示装置は、光量調節能力、視野及び発熱等と非発熱多くの利点があり、時計、照時計、電圧計等の各種装置の表示に用いられている。一方液晶表示装置の製造工程は、マスクを用いてエッチング、蒸着、塗布、乾燥、封入等の工程を経て成るが、





図14と表現されている。半導体基板表面を平坦化する層21は、ポリイミド樹脂、低融点ガラスあるいはその他の絶縁材がよい。ポリイミド樹脂の場合は、ポリイミドワニスとスピンナー装置により半導体基板の表面に約1〜5μの厚さでポリイミド膜を形成する。この場合下層とポリイミド膜との密着性を高めるために、シランカップリング剤をあらかじめ下地半導体基板に塗布していてもよい。その後350〜550℃で乾燥してキュアする。スルーホールは、ヒドラジン酸かNaOH液にてホトエッチングすればよい。その後、液晶駆動用電極を形成すればよい。ポリイミドを、半導体基板の平坦化材料として用いることは、ポリイミドは、有機樹脂の中では最も耐熱性に優れ、かつ線膨率が10ppm程度までクラックが生じることなく形成出来、パッシベーション効果も優れている点で非常に有用である。しかし、本発明は、ポリイミド膜で被覆するものではなく、低融点ガラス例えば、PbO<sub>2</sub>を主成分とした鉛ガラスでもよいし、ZnO<sub>2</sub>を主成分とした亜鉛ガラスでもよい。

さらに、図15を主成分としたリンガラスでもよい。いずれの材質にしても、形成後の半導体基板の表面の段差が4.5μ以下となれば、本発明を満足するものとなる。以上の方法により成る平坦化された半導体基板とへ加え蓋材により配向膜を形成すれば、図5図中の20あるいは、図6図中の20に示す如く、表示領域のはほとんどすべての領域に配向処理が出来るため、液晶表示パネルのコントラストはすばらしく向上し、かつ見やすい表示パネルが可能となる。図6図中の23は、表面が平坦化された半導体基板であり、24は液晶駆動電極である。本発明による平坦化された半導体基板を用いることにより、液晶表示パネルのコントラストは従来のものと比べて数倍に向上した。

本発明では半導体基板として主成分より8割のトランジスタを含む基板について説明して来たが本発明はこれに限るものではなく、主成分は酸トランジスタを含む基板でもよいし、又、よりS基板にも適用されることは言うに及ばない。又、半導体基板中には、駆動素子だけが含まれていて

もよいし、又、受動素子だけが含まれていてもよいことも、もちろんである。本発明の液晶表示セルを液晶表示テレビへ応用した場合、高いコントラストが与えられ、非常に有効である。この場合の液晶は、駆動電圧が低い、なじれネマチック型液晶でもよいし、又、ネマチック液晶に2色生染料を混合した液晶でもよい。いずれにしても、表面が平坦化された半導体基板を用いることにより液晶の早さか均一化出来ることもあり、コントラストの向上が期待出来る。

本発明は、上述した如く、液晶表示パネルのコントラストを高めるために、表示パネルの一方の基板に用いた半導体基板の表面を平坦化処理したことを特徴とする液晶表示パネルに属するものであり、コントラストの向上が期待出来るものである。

#### 図面の簡単な説明

- 図1図は液晶表示パネルの断面構造を説明する図。  
図2図は従来の半導体基板の表面用配向膜と被

す断面構造図。

図3図は表面凹凸が激しい基板への配向処理を示す図。

図4図は表面が平坦なガラスへの配向処理を示す図。

図5図は本発明による表面が平坦化された半導体基板を示す断面構造図。

図6図は本発明による表面が平坦化されたガラスへの配向処理を示す図。

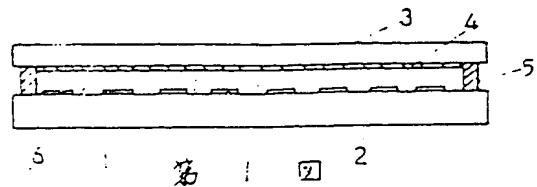
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| 3…平坦化ガラス板  | 4…液晶表示領域 |
| 5…スルーホール   | 6…液晶     |
| 7…液晶シリコン基板 |          |
| 8…液晶駆動電極   | 9…液晶表示領域 |
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- 17 ... 切め盛付方向    18 ... 切め盛付線  
 19 ... ガラス板        20 ... 切め盛付口  
 21 ... 半導体表面を平坦化する層  
 22 ... 液晶駆動電極  
 23 ... 表面が平坦化された半導体基板  
 24 ... 液晶駆動電極

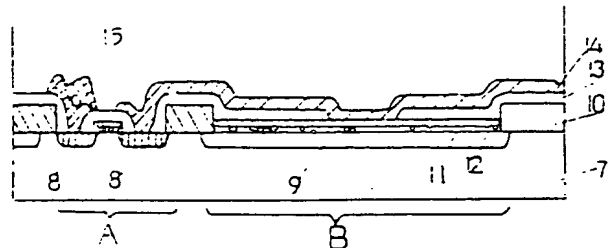
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出願人 株式会社 京 防 研 工 会

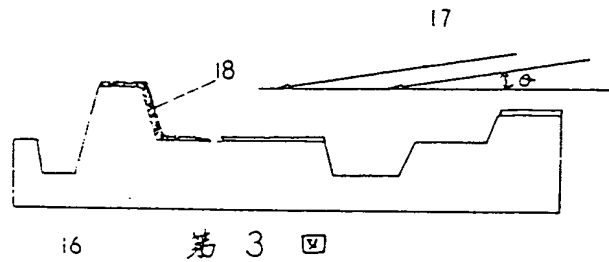
代理人 最 上 務



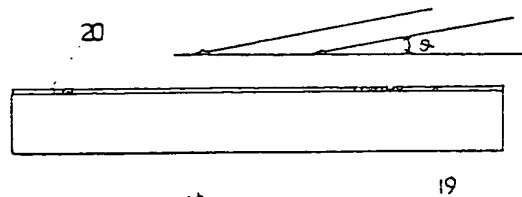
第 1 図



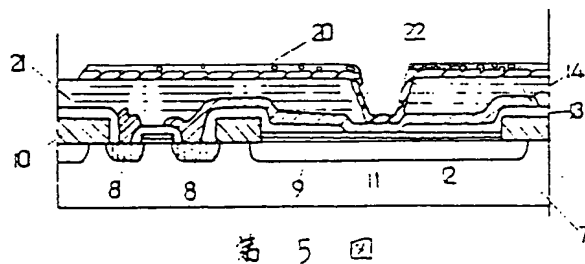
第 2 図



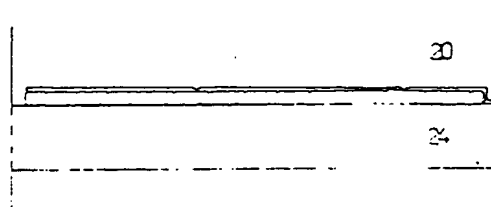
第 3 図



第 4 図



第 5 図



第 6 図

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